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Experimental Investigation of CO2, Lean and Flue Gas Injection in a Tight Danish North Sea Oil Reservoir

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Most of the Danish oil and gas is produced from Upper Cretaceous reservoirs, located in the North Sea. The rock is composed of chalk with some clay minerals as a minor impurity. Chalk is commonly considered tight, although it typically has high porosity. However, to adjust to the increasing demand for hydrocarbons, extraction of petroleum from less favorable reservoirs like the tight, high porosity low permeability mixed sediment formations in the Lower Cretaceous is needed. Lower Cretaceous oil reservoirs in the Danish part of the North Sea, are not suited to any water-based recovery method due to the depth and low permeability. The only practicable recovery method could be gas injection, and one of the targeted gases for injection could be produced gas which has good compatibility with the reservoir fluids. Another option could be the captured flue gas from industrial sites which have almost 13% CO2 content. A pure CO2 injection is also an attractive option since depleted oil and gas reservoirs are potential sites for CO2 storage projects and more CO2 will become available in the future. Therefore, this research aims to evaluate the potential of lean gas, flue gas, and supercritical CO2 injection, as well as the effect of injection pressure on incremental oil recovery in a Lower Cretaceous oil reservoir. In this study, a core plug from the Tuxen formation in the Lower Cretaceous without any open longitudinal fractures was selected after CT scanning of the core sample. To exclude the effect of rock quality on recovery results, a single core plug was re-used for all experiments. Porosity and permeability were measured before each experiment and these properties showed no change between experiments. In each experiment, the saturated core plug was aged in crude oil for four weeks under reservoir conditions (P and T). The dead oil was then displaced by live oil. The gas injection experiments afterward were conducted at two different pressures, 250 and 350 bar, at the reservoir temperature of 85 ℃. The results show that pure CO2 has the best sweep efficiency, followed by lean gas and flue gas. By comparing the pure CO2 and flue gas (Mixture of 13% CO2 and 87% N2) results, it is obvious that the high N2 content has a negative effect on final recovery. Injection pressure shows a remarkable effect on lean gas efficiency due to higher miscibility in crude oil at elevated pressure but has a minor effect on pure CO2 and flue gas results. Results suggest that CO2 injection is an attractive solution for enhancing oil recovery in tight chalk reservoirs not only because of its higher sweep efficiency but also considering its high storage efficiency and the increasing demand for CO2 storage projects.

Participation

In-Person

References

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